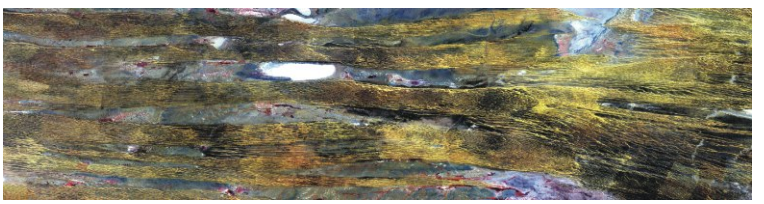
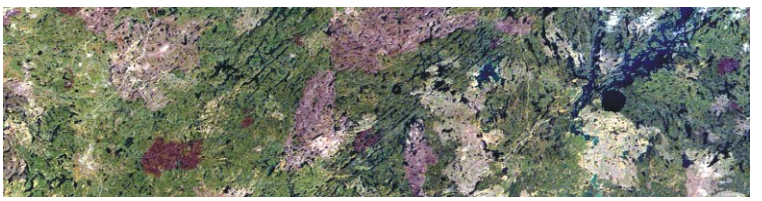
Geographic Information Science Center of Excellence

South Dakota State University

USGS National Center for Earth Resources Observation and Science





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The Geographic Information Science Center of Excellence (GIScCE) is a joint collaboration between South Dakota State University (SDSU) and the United States Geological Survey's National Center for Earth Resources Observation and Science (EROS). The purpose of the GIScCE is to enable South Dakota State University faculty and students, and EROS scientists to carry out collaborative research, seek professional development, and implement educational programs in the applications of geographic information science.

The idea for the GIScCE was formed and implemented by administrative leaders at SDSU, EROS and the South Dakota State Board of Regents, and represents a unique partnership that strengthens both SDSU and EROS. EROS, a longtime collaborator with researchers at SDSU, is the largest civilian repository of remotely sensed data sets and a renowned center of applied earth systems science. In recognizing these strengths, a primary emphasis of the GIScCE will be the use of remotely sensed data sets to study the land surface and its modification over time.

The GIScCE will employ the capabilities of geographic information science, namely remote sensing, geographic information systems, digital mapping, and geostatistics, to document and understand the changing earth. To fully achieve this, an interdisciplinary center of study is required, one which utilizes engineering principles to efficiently and accurately process earth observation data, geographic principles to create meaningful thematic depictions of land cover and land use change, and applications which focus on the resultant effects of change on the geosphere, biosphere and hydrosphere. To date, 13 researchers from SDSU and EROS have been recruited to constitute the GIScCE staff of Senior Scientists. By serving the South Dakota, national and international communities through the teaching activities and research investigations of the GIScCE staff, we expect SDSU to be recognized as a global center of expertise in geographic information science studies.

Dr. Matthew Hansen (Co-Director) is a remote sensing scientist at SDSU with a research specialization in large area land cover and land use change mapping. Dr. Hansen's research is focused on developing improved algorithms, data inputs and thematic outputs which enable the mapping of land cover change at regional, continental and global scales. Such maps enable better informed approaches to natural resource management, including deforestation and biodiversity monitoring and can also be used by other scientists as inputs to carbon, climate and hydrological modeling studies. Dr. Hansen is currently an Associate Team Member of NASA's MODIS Land Science Team, responsible for the algorithmic development and product delivery of time-series maps of global forest cover, croplands and other vegetation cover types. He also works on mapping deforestation within the Congo Basin as part of the Central Africa Regional Program for the Environment, a USAID-funded project. Other current research includes improving global cropland monitoring capabilities for the Foreign Agriculture Service of the USDA. Dr. Hansen entered the field of remote sensing after serving with the Peace Corps in Zaire and has a Ph.D. in Geography from the University of Maryland, M.A. in Geography and M.S.E. in Civil Engineering from the University of North Carolina at Charlotte, and a B.E.E. in Electrical Engineering from Auburn University.

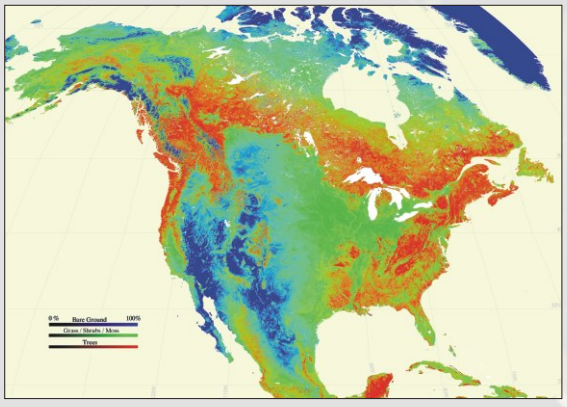


Fig. 1

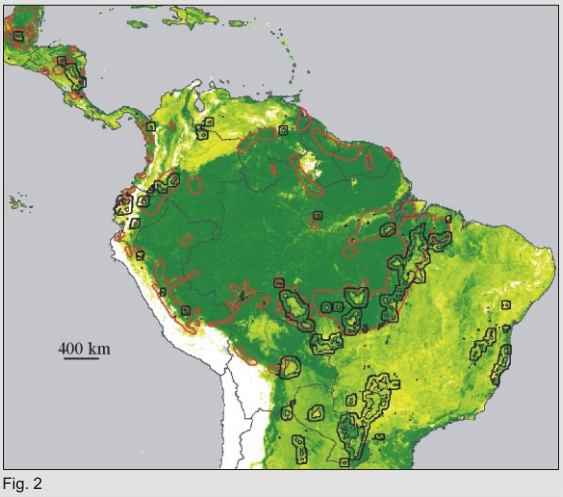
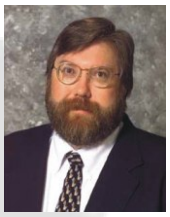


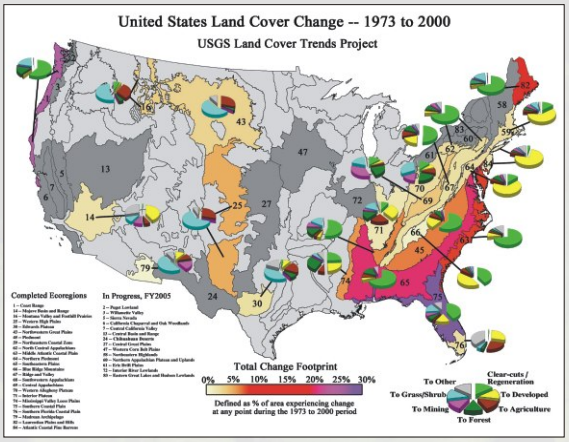
Fig. 2

Fig. 1. Percent land cover map of North America in three components: tree canopy cover (red), herbaceous and shrub cover (green), and bare ground (blue), summing to 100 percent. Such maps enable the monitoring of land cover and land use change over time.

Fig. 2. Hot spots of change map for forest cover in South America, 1982-1999, derived from time-series percent tree cover maps. Black outlines represent areas detected in automated fashion using remotely sensed data sets, red outlines represent areas delineated based on expert opinion only. Results from this study showed an increase in the global rate of deforestation during the 1990's compared to the 1980's, in contradiction to data from the Forest Resource Assessment Programme of the United Nation's Food and Agriculture Organization.



Dr. Tom Loveland (Co-Director) is a research geographer at EROS and director of the USGS Land Cover Institute. He has been engaged in research on the use of remote sensing for land use and land cover investigations for over 25 years and has conducted studies that have spanned local to global scales. He was among the first to create continental and global-scale land cover data sets derived from remotely sensed imagery. He currently leads a USGS research team that is developing a contemporary land cover history of the United States. In addition, Dr. Loveland is leading the Landsat Continuity Mission Science Team and is a member of the NASA National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project science team. He is a member of the editorial board for the Journal of Land Use Sciences and has served in leadership roles in a number of national and international science organizations including the American Society of Photogrammetry and Remote Sensing, Climate Change Science Program, and the International Geosphere-Biosphere Programme. Dr. Loveland has published almost 90 scientific papers and has received career achievement awards from the American Society of Photogrammetry and Remote Sensing and the Association of American Geographers. Dr. Loveland has a Ph.D. in Geography from the University of California, Santa Barbara and B.S. and M.S. degrees in Geography from South Dakota State University.



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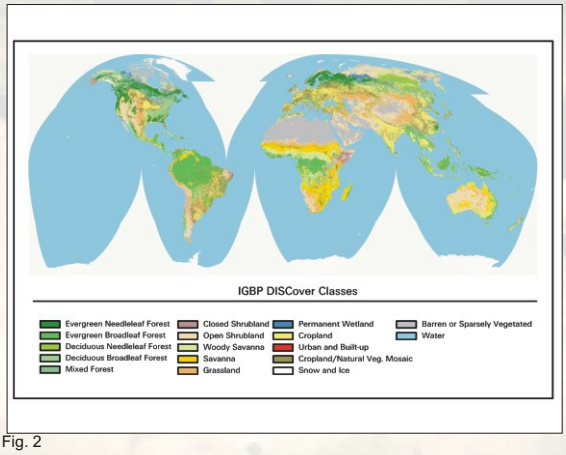
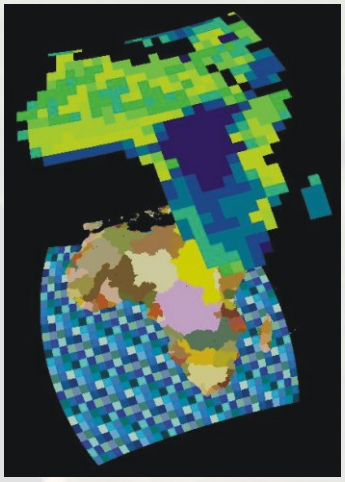


Fig. 2

Fig. 1. Variability in the rates and types of land cover change in selected United States ecoregions.
Fig. 2. IGBP 1km DISCover land cover data set, the first moderate resolution map of global land cover derived using remotely sensed data sets.

Dr. Kwabena Asante is a surface water hydrologist at EROS who specializes in monitoring the earth's rivers and lakes using remotely sensed data sets and hydrologic models. In particular, he develops operational models for forecasting and mapping large-area flood events around the world. The products of this monitoring are used to brief disaster managers at the Office of Foreign Disaster Assistance, US Agency for International Development, and other agencies working in at-risk communities around the world. These applied research efforts help to save lives and reduce damage to property. He recently spent two years in southern Africa developing the Lower Limpopo Flood Warning System, an Atlas of Disaster Preparedness and Response, and assisting in the implementation of regional early warning systems. He is currently involved in water resource management projects in Africa, South-East Asia and North America. He entered the field of hydrology during his academic career which included simulating the operation of large reservoirs and investigating surface runoff processes at the continental-scale. He also implemented a scheme for predicting the distribution of streamflow entering the world's oceans from the land surface in a coupled global climate model. He holds Ph.D. and M.S. degrees in Civil Engineering from the University of Texas at Austin and a B.S. from the University of Nairobi, Kenya.

Fig. 1



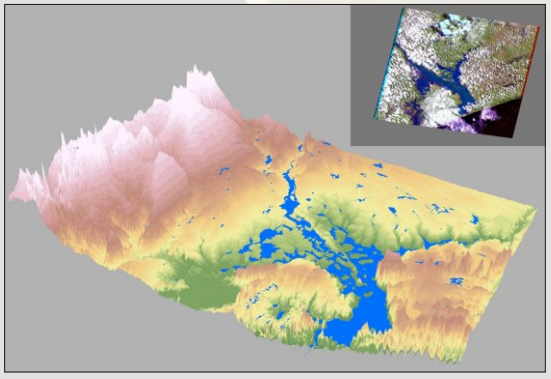
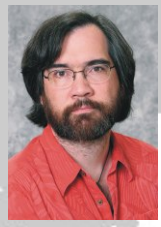


Fig. 2

Fig. 1. A source to sink hydrologic model showing the coupling of the major river basins of Africa to an atmospheric model and an ocean model. This study provided climate modelers with a way to simulate the transportation of surface water to various parts of the ocean with appropriate timing delays.

Fig. 2. A digital terrain model representation of a major flooding event in Mozambique with an inset of the corresponding Landsat 7 satellite image of the flood. Digital terrain models are used to study potential impacts of flooding on vulnerable populations and infrastructure.



Dr. Mark Cochrane of SDSU conducts interdisciplinary work that combines remote sensing, ecology and other fields of study to provide a landscape perspective of the dynamic processes involved in land-cover change. He is an expert on wildfire in tropical ecosystems, documenting the characteristics, behavior and severe effects of fire in tropical forests that are inherent to current systems of human land-use. His research focuses on understanding spatial patterns, interactions and synergisms between the multiple physical and biological factors that affect ecosystems. Recently published work emphasizes the human dimensions of land-cover change and the potential for sustainable development, and has been instrumental in the Brazilian government's recent program to expand its national forest system in the Amazon to 50 million hectares. In his ongoing research programs, Dr. Cochrane continues to investigate the drivers and effects of disturbance regime changes resulting from various forms of forest degradation, including fire, fragmentation and logging. He currently has funded projects in Brazil through NASA and USAID and in China (NASA). He holds a Ph.D. in Ecology from Pennsylvania State University and a S.B. in Environmental Engineering from the Massachusetts Institute of Technology.

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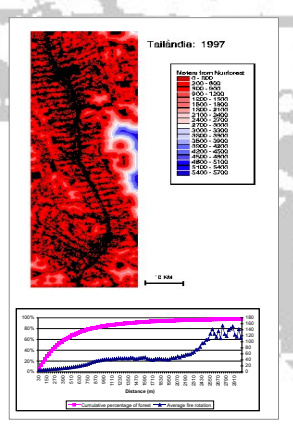

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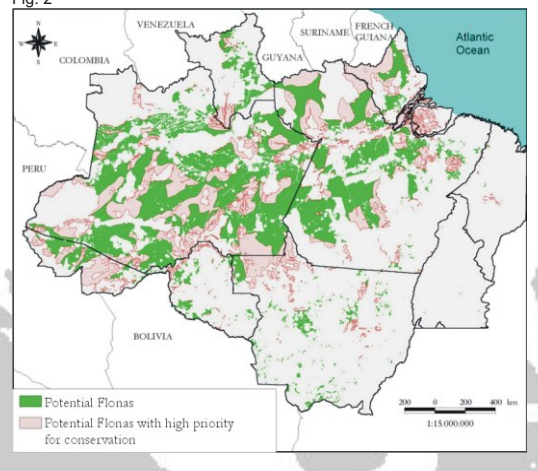
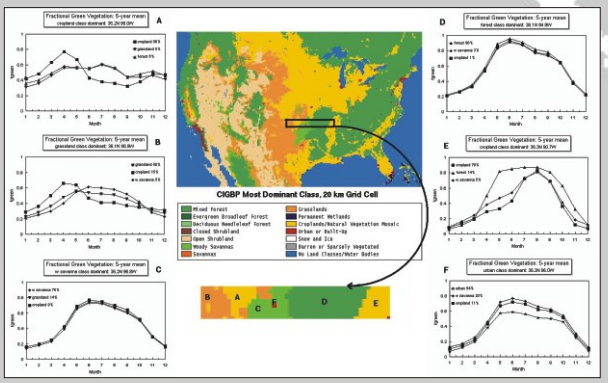


Fig. 1. Spatial distribution of fire regimes. Black areas are previously deforested while other colors represent standing forests suffering different levels of fire impact. Forests in red are burning too frequently to persist as tropical evergreen forests and are transitioning to grassland and scrub. Graph shows both cumulative percentage of remaining forests and fire frequency (average return interval in years) as a function of distance from deforested edges in the eastern Amazon.
Fig. 2. Map of forests in the Brazilian Amazon which could be designated as National Forests (FLONAS) without conflict with existing conservation lands or human inhabitants.

Dr. Kevin Gallo is a physical scientist with the Center for Satellite Applications and Research of NOAA/NESDIS and physically located at the EROS, where he is the lead investigator on several collaborative research efforts related to land-atmosphere processes and interactions. Dr. Gallo's research activities have included fundamental and applied issues related to satellite-based assessment of urban heat island phenomena (warmer air temperatures associated with urban compared to rural environments). More recently, Dr. Gallo has been active in research on the use of remotely sensed data to characterize and monitor land surface related biophysical variables used in numerical weather forecast models. He has also initiated comparisons of several remotely-sensed data sets to determine the continuity of historic and current satellite-derived vegetation indices with those of future sensors. Dr. Gallo is currently a member of the Visible/Infrared Imager/Radiometer Suite (VIIRS) Operational Algorithm Team, the NOAA/NESDIS Land Surface Product Oversight Panel, and the NASA/EOSDIS Land Processes Distributed Active Archive Center's Science Advisory Panel. Dr. Gallo holds Ph.D. and M.S. degrees in Agricultural Climatology/Remote Sensing from Purdue University and a B.S. degree in Geography/Meteorology from Northern Illinois University.

Fig 1.



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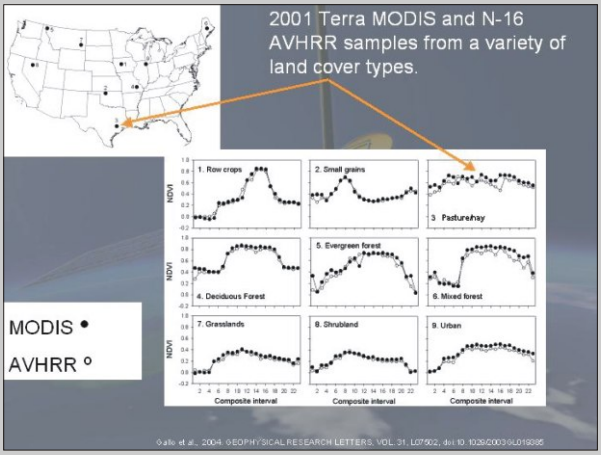
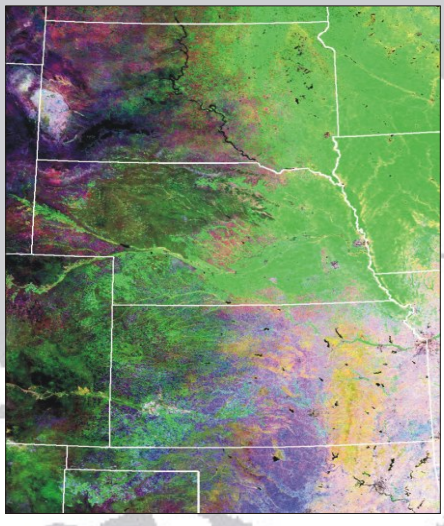


Fig 1. Five-year mean monthly satellite-derived fractional green vegetation cover (fgreen) for the three most dominant land cover classes at six different locations in the South-Central Plains of the United States. Fractional green vegetation cover is a land surface variable used in numerical weather forecast models.
Fig 2. Time series of the normalized difference vegetation index (NDVI) observed with the AVHRR (onboard NOAA-16) and MODIS (onboard Terra) sensors for nine different land cover types as part of a sensor intercomparison and data continuity study.

Dr. Geoffrey Henebry of SDSU is an ecologist whose research focuses on developing theory and technique to improve the analysis of image time series and the modeling of ecological phenomena. He is currently investigating the effects of the collapse of the Soviet Union on the arrival of spring in European Russia and Central Asia and the consequences for regional precipitation patterns. He also works on a USDA-funded project modeling the interannual variation in forage production in the grasslands of the Northern Great Plains and serves as a co-investigator on the multidisciplinary Sand Hills Biocomplexity project, funded by the NSF, which studies the processes that enable the stability of the largest dune field in the Western Hemisphere. As a Fulbright Senior Research Fellow at the Brazilian Space Agency in 1993-94, Dr. Henebry used imaging radar to investigate flooding patterns in the Pantanal Matogrossense, the largest wetland on the planet. Dr. Henebry is a member of NASA's Land Use Land Cover Change Science Team and the Northern Eurasia Earth Science Partnership Initiative Science Team. He entered the field of ecological remote sensing while serving as a post-doctoral fellow with the Konza Prairie Long Term Ecological Research project at Kansas State University. He earned a Ph.D. and a M.S., both in Environmental Sciences, from the University of Texas at Dallas, and a B.A. in Liberal Arts from St. John's College in Santa Fe.

Fig. 1



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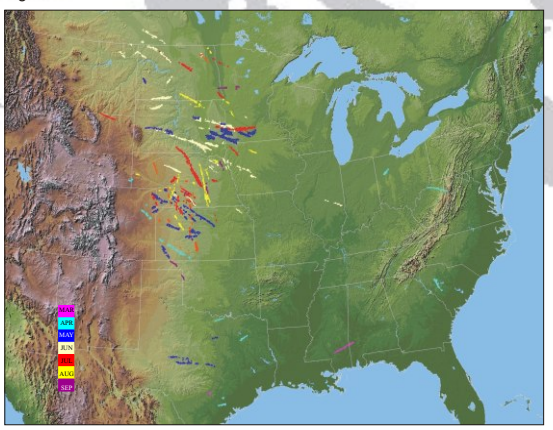

Fig. 1. Differences in land surface phenology across the Northern Great Plains as revealed by MODIS NDVI at 1 km resolution. This false color composite places three 16-day composites in the red, green, and blue color planes: red = 08MAY04; green = 27 JUL04; blue=08MAR04. **Fig. 2.** A shaded relief map showing 112 large swaths of devegetation caused by hailstreaks during the 1990s. Color denotes the month of occurrence. The AVHRR NDVI datasets used to identify the devegetated areas were produced at the USGS National Center for Earth Resources Observation and Science. Many of these devegetation events (20%) covered more than 1,000 km^2 and the largest covered more than 8,000 km^2.

Dr. Shuguang (Leo) Liu of EROS specializes in development and applications of complex modeling and decision-support systems to simulate human-land-atmosphere interactions and environmental consequences at various spatial scales. With funding from the US Geological Survey, NASA, Department of Defense, USAID and NSF, Dr. Liu's current research activities include (1) developing advanced data assimilation systems to enhance capability in monitoring and forecasting the status and trends of terrestrial ecosystems using models and observations from ground and space, (2) quantifying the spatial and temporal dynamics of CO_2 exchange between the terrestrial biosphere and the atmosphere with a special emphasis on the impacts of land use and climate change for the United States and Africa, (3) investigating the impacts of soil erosion and deposition on ecosystem productivity, soil profile evolution, and atmospheric CO_2 concentration, (4) developing a spatially distributed biogeochemical modeling system to support the sustainable management of a military installation, and (5) developing an integrated ecological and economic modeling system for estimating carbon sequestration supply in Costa Rica. Dr. Liu has a Ph.D. in Forestry with an emphasis on watershed management and hydrology from the University of Florida, a M.S. in Forest Ecology from Beijing Forestry University and a B.S. in Forest Science from Central-South Forestry College, Zhuzhou, China.

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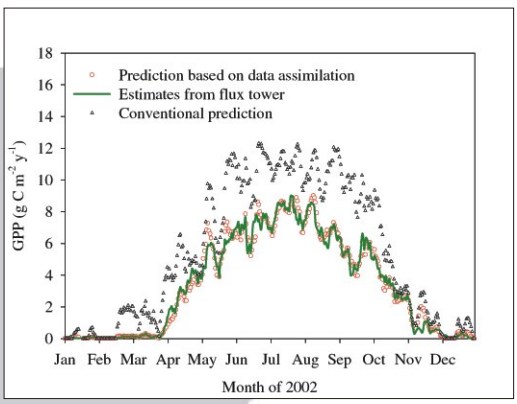

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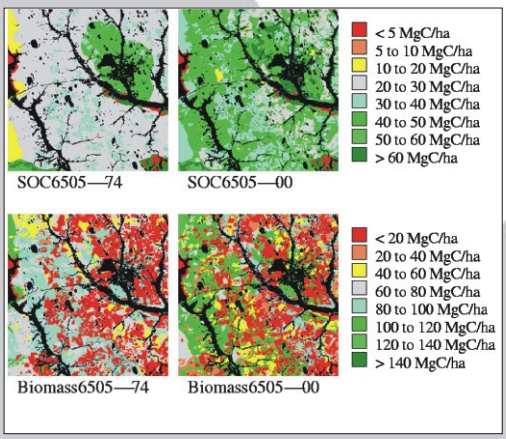
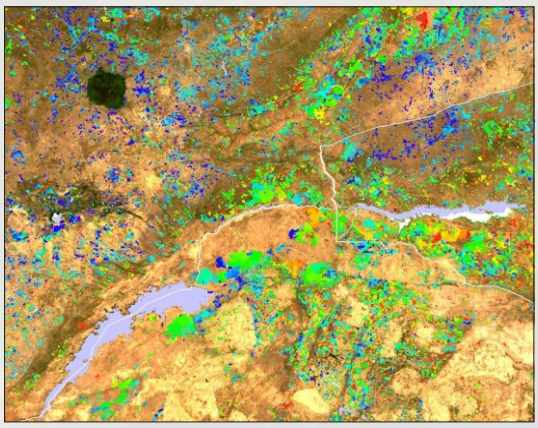


Fig. 1. Comparison of the simulated gross primary production (GPP) with eddy flux tower measurements. Figure shows data assimilation techniques can dramatically improve model performance. The driving forces of the models include remotely sensed vegetation and climate conditions. **Fig. 2.** Spatial patterns of carbon stocks in soil (SOC) and biomass in 1974 and 2000 in a 10-km by 10-km block in the southeastern United States. Carbon stocks were simulated using the General Ensemble biogeochemical Modeling System (GEMS) at a spatial resolution of 60 m.

Dr. David Roy of SDSU has research interests that include the development of remote sensing and advanced computing methods to map and characterize terrestrial change, in particular the occurrence and spatial extent of vegetation fires, and the causes and consequences of land cover and land use change. He has worked primarily with global coverage moderate spatial resolution satellite data with an emphasis on southern Africa. Dr. Roy is involved in the development of earth science information systems to ensure the improved use and distribution of satellite derived products by the scientific global change and applied user communities. He held post-doctoral research fellowships at the U.K. Natural Environment Research Council Unit, University of Reading, and at the Space Applications Institute, Joint Research Centre of the European Commission, Italy. Before moving to SDSU, he was a research scientist at the Department of Geography, University of Maryland, and for eight years led the Moderate Resolution Imaging Spectroradiometer (MODIS) Land Data Operational Product Evaluation group at NASA's Goddard Space Flight Center. Dr. Roy has a multi-disciplinary academic background with a Ph.D. in Remote Sensing from the University of Cambridge, a M.S. in Remote Sensing and Image Processing from the University of Edinburgh and a B.S. in Geophysics from the University of Lancaster, United Kingdom.

Fig. 1



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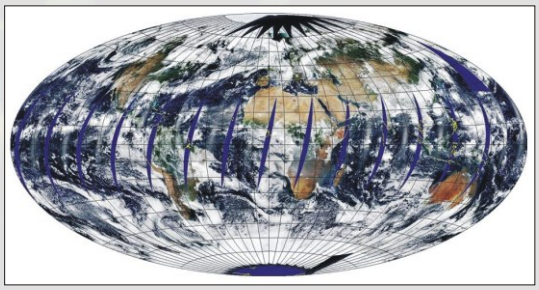
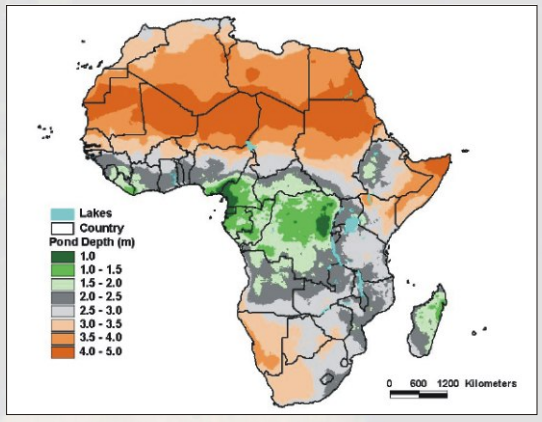


Fig. 1. Fire-affected areas detected using MODIS satellite data within a 650km by 500km region encompassing the southern border of Zambia, the northern border of Zimbabwe, and western borders of Mozambique (borders shown in white). The location and approximate day of burning is mapped over five months of the dry season from May 1st (Blue) to October 31st (Red) 2002. Lakes Kariba and Cahora Bassa are shown as grey.
Fig. 2. A daily acquisition of MODIS data, September 7th 2000. Creating consistent, long-term, global satellite data products requires rigorous production and quality assessment protocols.

Dr. Gabriel Senay is an agricultural engineer and remote sensing scientist at EROS. He specializes in monitoring agricultural water requirement, soil moisture and other crop performance indices derived from remotely sensed data. This monitoring is undertaken to assess agricultural crop performance and provide early warning of large-scale droughts. His crop monitoring products are used for decision-making in a wide variety of agencies including USAID, USDA, the World Food Program and the World Bank. He is currently involved in monitoring crop performance in Africa, Central America and South-East Asia and developing new algorithms for computing evapotranspiration from remotely sensed data. His efforts to make remote sensing technology applicable to small-scale farmers and other end-users have been recognized through several local and national awards. Dr. Senay has worked for the US EPA as a remote sensing scientist, developing a water quality mapping program in the monitoring of the "health" status of stream ecosystems using remotely sensed data and worked as a post-doctoral fellow at Oklahoma State University where he participated in the Southern Great Plains field experiment. He is a licensed professional engineer and obtained a Ph.D. in Agricultural Engineering from The Ohio State University, a M.S. in Hydrology from Wageningen University, Netherlands and a B.S. in Agricultural Engineering from Alemaya University in Ethiopia.

Fig. 1



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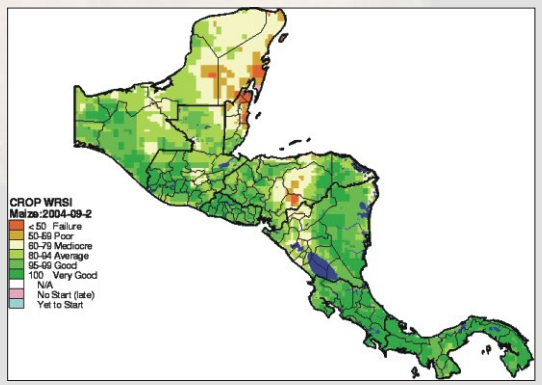
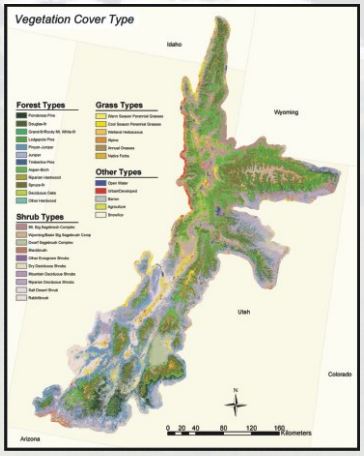


Fig. 1. Part of an Africa-wide study on water harvest potential showing the required pond depth to maintain a net depth of 1 m of water in one year after accounting for evaporation losses based on a daily water balance study.
Fig. 2. An operational Crop Water Requirement Satisfaction Index map depicting the crop performance status in Central America in 2004.

Dr. Jim Vogelmann of EROS has formal training in botany and ecology, and his current research employs satellite remote sensing to assess large area vegetation characteristics and changes. Dr. Vogelmann's research focuses on using remote sensing data and ancillary sources of geospatial information, and field observations for developing large region land cover data sets. Projects that he has worked on recently include landscape characterization for fire hazard evaluation, assessment of effects of instrument artifacts on standard applications products, analysis of multi-temporal remotely-sensed data sets for assessing landcover changes, and developing operational methodologies for employing remote sensing data for large area land cover mapping. He has also worked on other environmental issues, including using remote sensing for assessing "acid rain" forest decline, insect defoliation and forest fragmentation. Dr. Vogelmann is currently serving as EROS task lead for the LANDFIRE project. Previously, he served on the Landsat 7 Science Team, and as EROS task lead for the Multi-Resolution Land Characteristics Project, a national assessment of land cover which used Landsat data as inputs. Dr. Vogelmann has a Ph.D. in Plant Sciences from Indiana University and a B.A. in Botany from the University of Vermont.

Fig. 1. Vegetation types in central Utah as derived using Landsat data. This data layer is being used to help predict fire fuels loading and fire hazards.
Fig. 2. Monitoring forest change in the high elevation forests of Vermont. Changes in near infrared reflectance, which are depicted by different colors, indicate where forest changes have taken place across a 23 year time span.

Fig. 1



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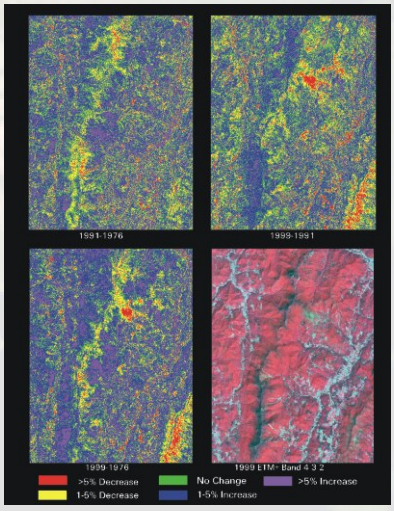


Dr. Mike Wimberly of SDSU is a spatial ecologist with a primary research emphasis on the development and application of geospatial models and analysis techniques. He is particularly interested in developing tools and methodologies that can be used to address public health and natural resource management issues at regional scales. Dr. Wimberly is currently the principal investigator on an NIH-funded grant that is applying regional land cover and climate databases along with novel spatial modeling techniques to map the causal agents of two emerging tickborne zoonoses. These maps will supply a framework for improved disease surveillance, and the underlying models will provide information on potential links between these diseases and global change. His research also includes the use of remotely sensed data and geospatial models to enhance regional assessments of fire risk and improve fuels management strategies. Current work includes developing and testing techniques for simultaneous mapping of multiple vegetation and fuels characteristics, and developing regional land cover change models that incorporate fire occurrences, vegetation responses, and fuel management treatments. Dr. Wimberly holds a Ph.D. in Ecology from Oregon State University, a M.S. in Quantitative Resource Management from the University of Washington and a B.S. in Environmental Science from the University of Virginia.

Fig. 1. Geographically-weighted regression results showing spatial variability in the correlation between the presence of *E. chaffeensis* (a tickborne zoonosis) in deer populations and forest cover derived from 1 km AVHRR data. Forest cover has a strong positive correlation with *E. chaffeensis* in the south-central states (dark blue dots), a weaker positive correlation in the mid-Atlantic states (light blue dots), and no correlation in other parts of the study area (small black dots).
Fig. 2. Percent of forest area susceptible to active crown fire and total (active + passive) crown fire in the southern Oregon Coast Range. Predictions are generated using the FLAMMAP model and are based on vegetation and fuel maps derived from Landsat TM imagery.

Fig. 1

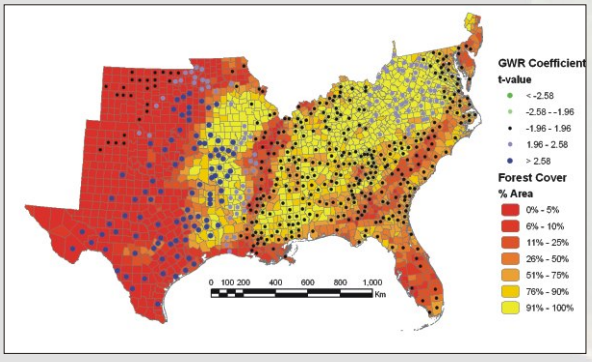
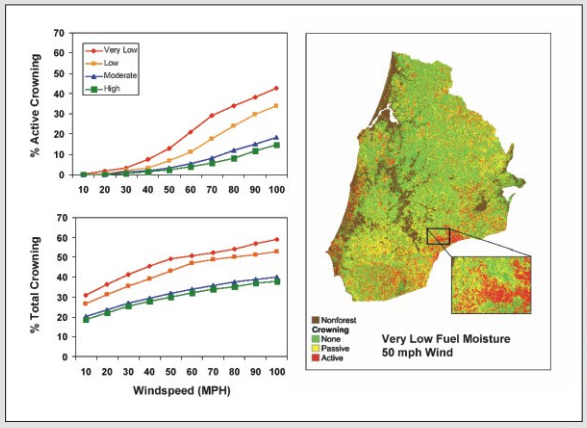


Fig. 2



Dr. Chunsun Zhang of SDSU is a photogrammetry scientist with a research specialization in automated mapping and feature extraction from remotely sensed imagery. Dr. Zhang's research is focused on the development of improved models, algorithms and computational systems for image matching, DEM/orthoimage generation, and feature extraction. Such capabilities allow for improved approaches to automated mapping, change detection and geodatabase updating. His research also involves sensor calibration, sensor orientation modeling, 3D surface analysis and interpretation, and multi-source data fusion, which are necessary to support metric feature extraction. Dr. Zhang has worked on automated reconstruction of topographic objects from aerial images using vectorized map information, funded by the Swiss Federal Office of Topography, and developed an operational stand-alone software for 3D road database updating. He is currently working on developing improved algorithms for geoinformation extraction from high resolution satellite imagery on a project funded by the Cooperative Research Center for Spatial Information in Australia. He has a Ph.D. in Photogrammetry and Remote Sensing from the Swiss Federal Institute of Technology and M.S. and B.S. degrees in Survey Engineering from Liaoning Technical University, China.

Fig. 1

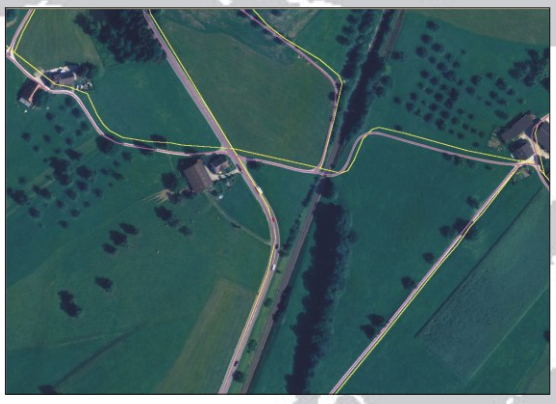


Fig. 2

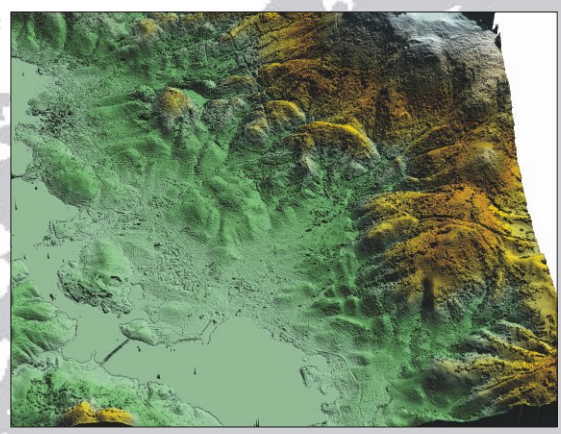


Fig. 1. Example of automated feature extraction of road networks using airborne imagery in Switzerland. Yellow lines represent incorrect delineation of roads from an archival database, magenta lines represent improved road locations from an automated feature extraction method.
Fig. 2. Example of digital terrain model derived in automated fashion from image stereo pairs for Hobart, Tasmania, Australia.

Dr. Zhiliang Zhu is a physical scientist at EROS. Dr. Zhu's research interests are in mapping and characterization of vegetation communities in terms of species composition and structure, large-area land and vegetation mapping, and applications of remotely sensed data to environmental assessment. His work includes national, regional and global scale land cover mapping and he produced the first percent forest cover map of the United States derived from remotely sensed data sets. In addition to large area mapping, his other research activities focus on developing methodologies for mapping ecological systems with a particular emphasis on fire ecology. Research themes in this area include deriving improved approaches to mapping vegetation canopy height and cover characteristics, wildland fuel data, burn severity, ecosystem responses to fire, baseline vegetation and fuel data with captured disturbance information and invasive species. Dr. Zhu is Co-PI of the LANDFIRE project, a national vegetation, wildland fuel, and ecosystem condition assessment project, and of the Monitoring Trends in Burn Severity project, a national fire monitoring project. Dr. Zhu holds a Ph.D. and M.S. in Natural Resource Management and Remote Sensing from the University of Michigan and a B.S. in Forestry from Nanjing Forestry University, China.

Fig. 1

Fig. 2

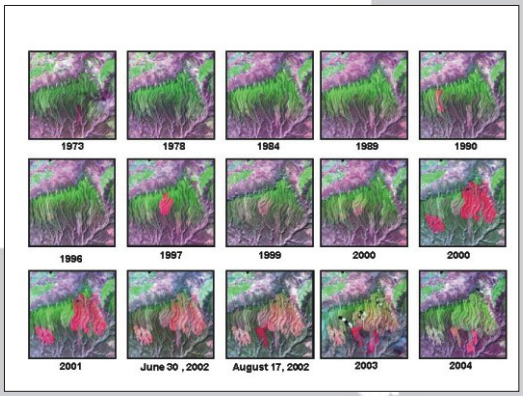


Fig. 1. National-scale map of forest cover types of the United States derived from using 1km spatial resolution AVHRR data. This map was one of the first to incorporate percent cover mapping at continental scales.
Fig. 2. Fire atlas of Mesa Verde National Park.

On the cover: cornfield and forest photos courtesy of Erik Lindquist. IKONOS imagery of Zambia courtesy of Space Imaging. Landsat 7 ETM+ image of southern Kalahari Desert. Rapid Response MODIS image of Canadian taiga courtesy of NASA Goddard Space Flight Center.
Background imagery: courtesy of NASA Goddard Space Flight Center Image by Reto Stöckli (land surface, shallow water, clouds). Enhancements by Robert Simmon (ocean color, compositing, 3D globes, animation).
Brochure layout and concept: Erik Lindquist and Matthew Hansen

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